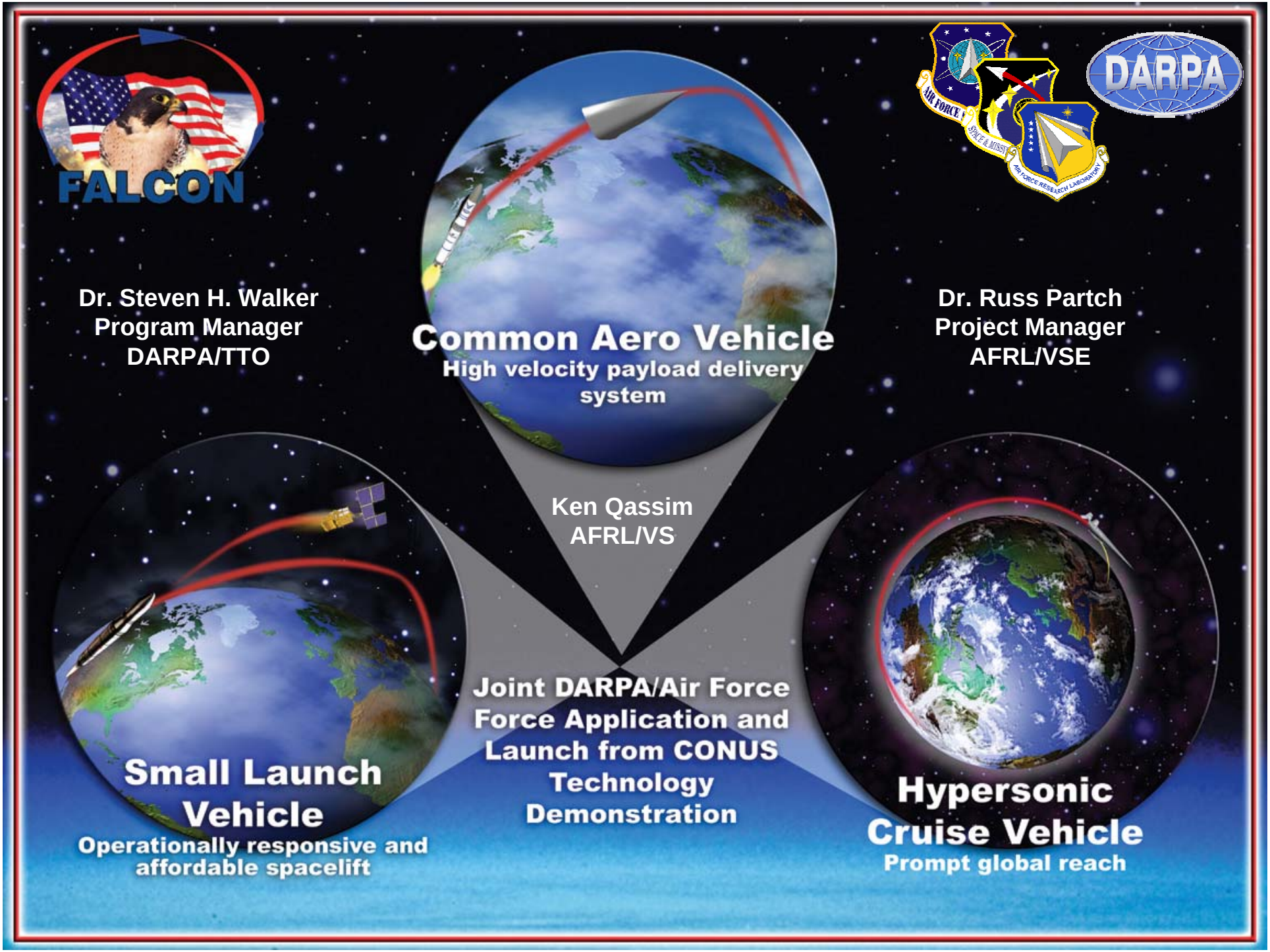
FALCON
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Dr. Russ Partch
Project Manager
AFRL/VSE
Ken Qassim
AFRL/VS
Small Launch Vehicle
Operationally responsive and affordable spacelift
Joint DARPA/Air Force
Force Application and
Launch from CONUS
Technology
Demonstration
Hypersonic Cruise Vehicle
Prompt global reach

Report Documentation Page

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15. SUBJECT TERMS

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PROGRAM GOAL

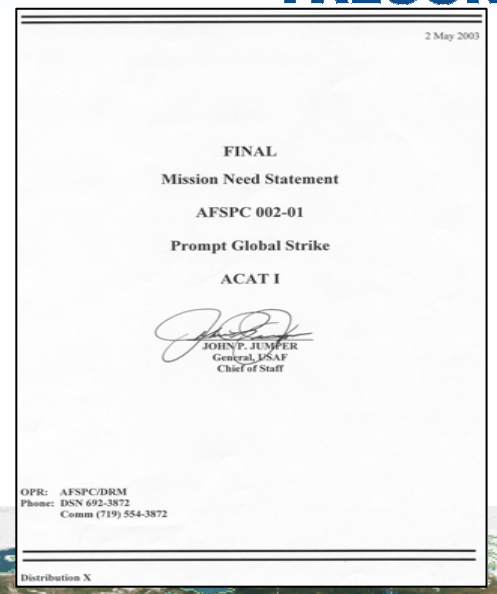
Develop and Validate, In-flight, Technologies that will Enable Both Near-term and Far-term Capabilities to Execute Prompt Global Strike Missions while at the Same Time, Demonstrating Affordable and Responsive Space Lift

HYPERSONIC FORCE APPLICATION AND LAUNCH TECHNOLOGY DEMONSTRATION

FALCON Program Advances Technology Necessary for Prompt Global Strike Capability

Prompt Global Strike (PGS) Requirements

- Strike globally and rapidly with joint forces against high-payoff targets
- In a timeframe reduced from weeks/days to hours/minutes
- Even when no permanent military presence or only limited infrastructure is in a region
- Regardless of anti-access threats
- In a single or multi-theater environment



2 May 2003

FINAL

Mission Need Statement

AFSPC 002-01

Prompt Global Strike

ACAT I

JOHN P. JUMPER
General, USAF
Chief of Staff

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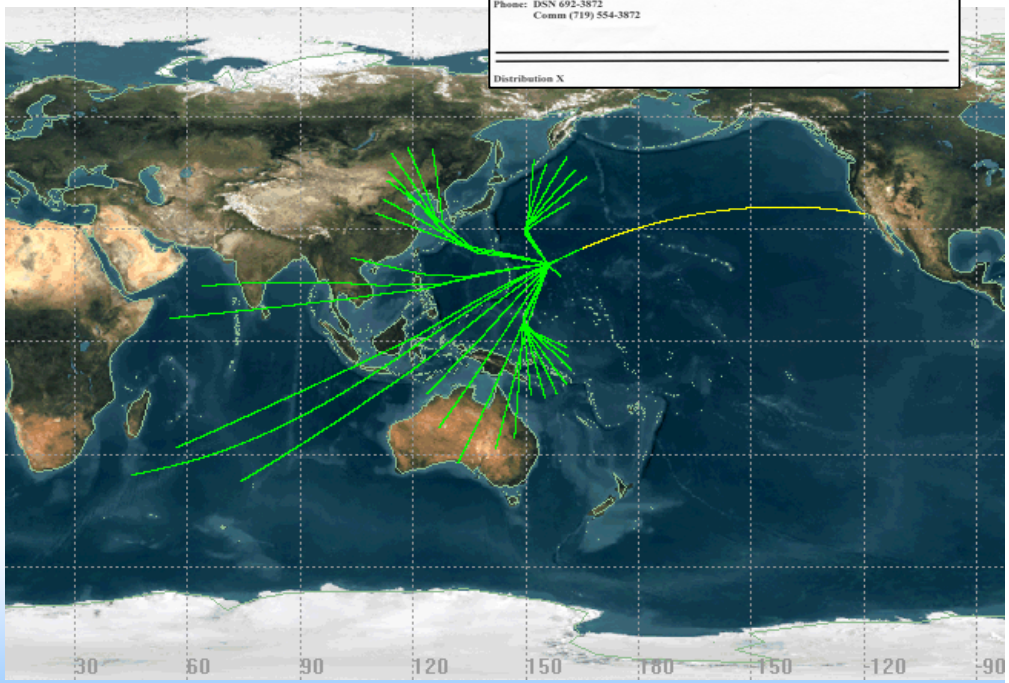
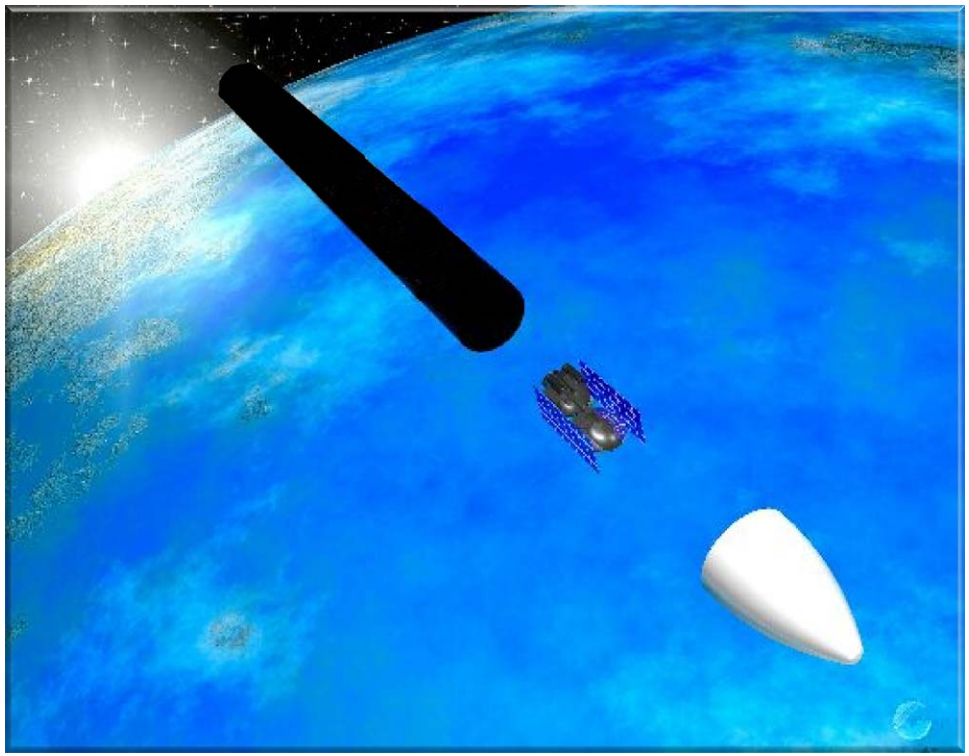


SMALL SATELLITE LAUNCH



Operationally Responsive Spacelift Capability

» **Small ISR payloads to Sun Synchronous Orbits**

» **Low Recurring Launch Cost**

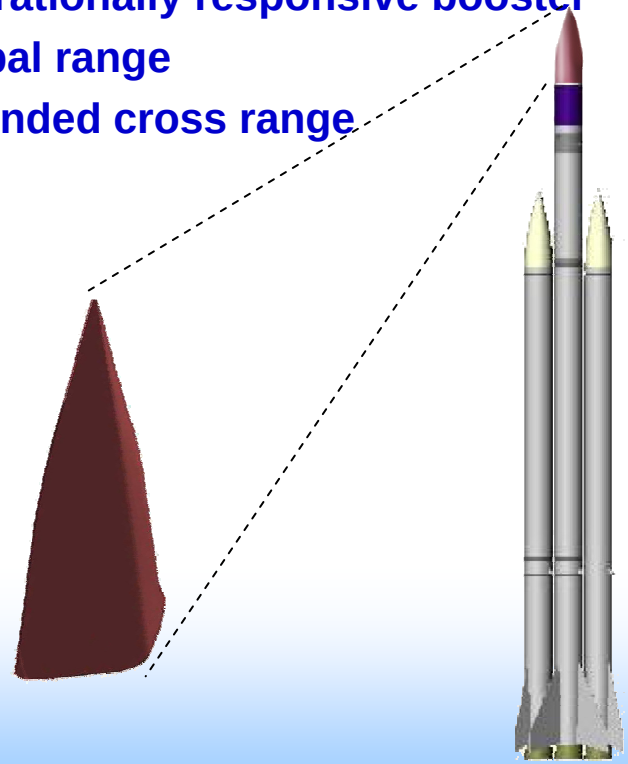
» **New Launch Operations Paradigm**

FALCON Hypersonic Technology Program will Achieve Near and Far Term PGS Objectives

Near Term Operational System

Common Aero Vehicle (CAV) and Small Launch Vehicle (SLV) System Capability:

- High Endurance CAV
  - Multiple payloads
  - Multiple munitions
- Operationally responsive booster
- Global range
- Extended cross range



FAR Term Operational System

Hypersonic Cruise Vehicle (HCV) System Capability:

- High Lift/Drag Configuration
- Multiple use payload bays
- Global down and cross range
- Aircraft operations
  - Reusable
  - Recallable
  - Launch on demand

Common Aero Vehicle (CAV)

Objective: CAV Technology Demonstration Flight Test

Description of CAV:

- Lifting aeroshell surviving >Mach 22 reentry velocity
- Maneuverable: >3000 nm range and >1000 nm crossrange
- Controllable with 3m accuracy objective

Hypersonic Technology Vehicle Flight Experiment:

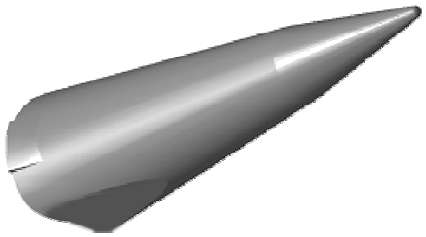
- Prototype vehicle with available (SOTA) technology
- Vehicle Test flight with instrumentation (no weapons)
  - **TPS effectiveness & endurance (3500 F outside, 160 F inside)**
  - **Integrated aerodynamic performance**
  - **Guidance, navigation, and control**
  - **Communications and plasma effects**

HYPERSONIC TECHNOLOGY EVOLUTION

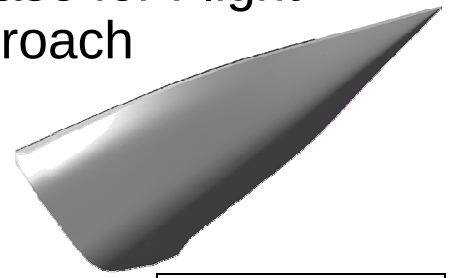
Building Block Tech Development and Flight Demo Approach

(Consistent with National Aerospace Initiative Philosophy)

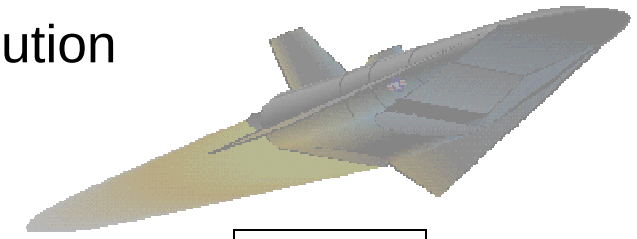
- CAV-to-HCV Demonstrator Design Evolution
- Multiple Opportunities to Flight Test Advanced Technologies
- Build Knowledge Base for Flight Demonstration Approach
  - Launch Site
  - Launch Ops
  - Flight Ops



HTV



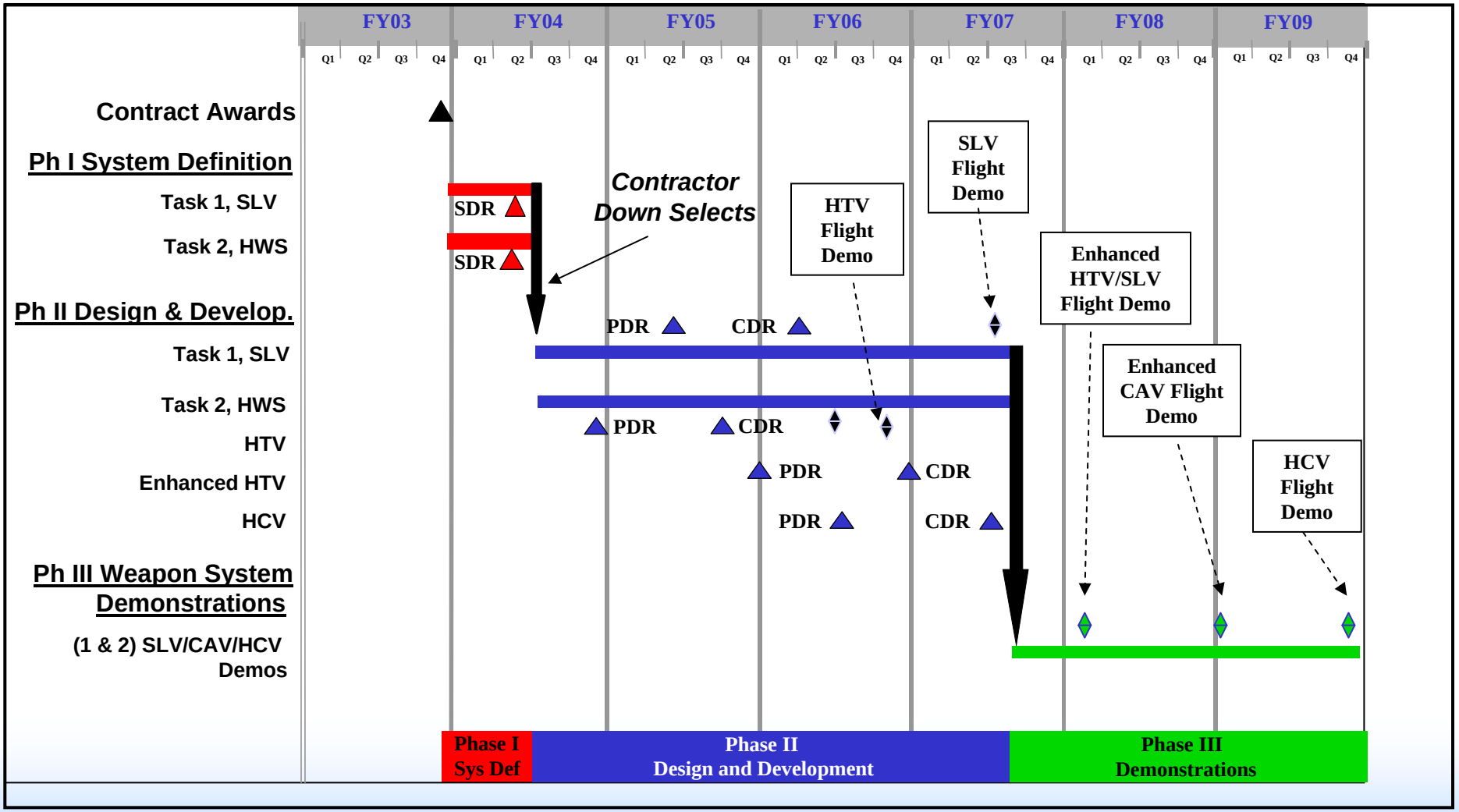
Enhanced HTV

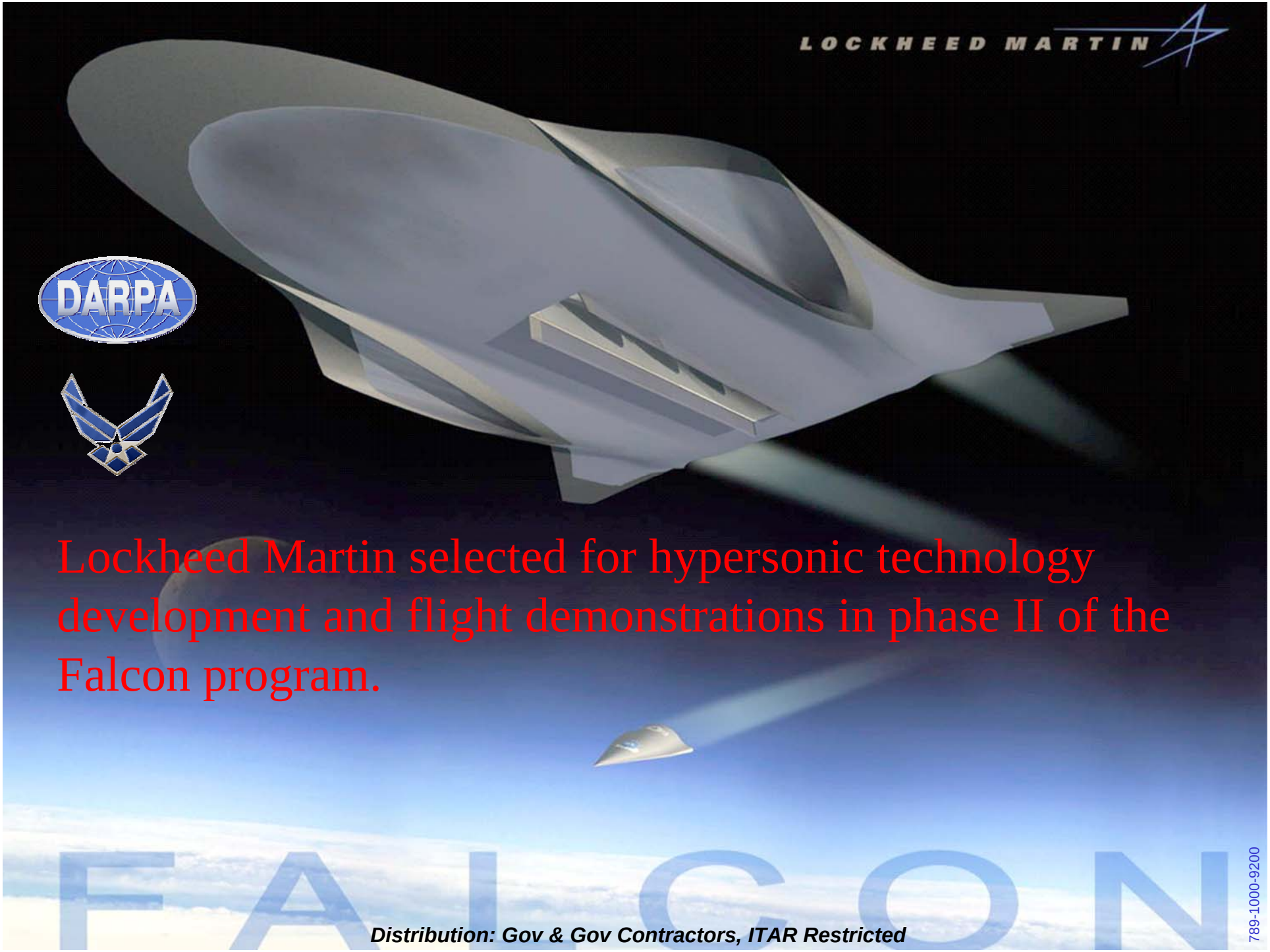


HCV

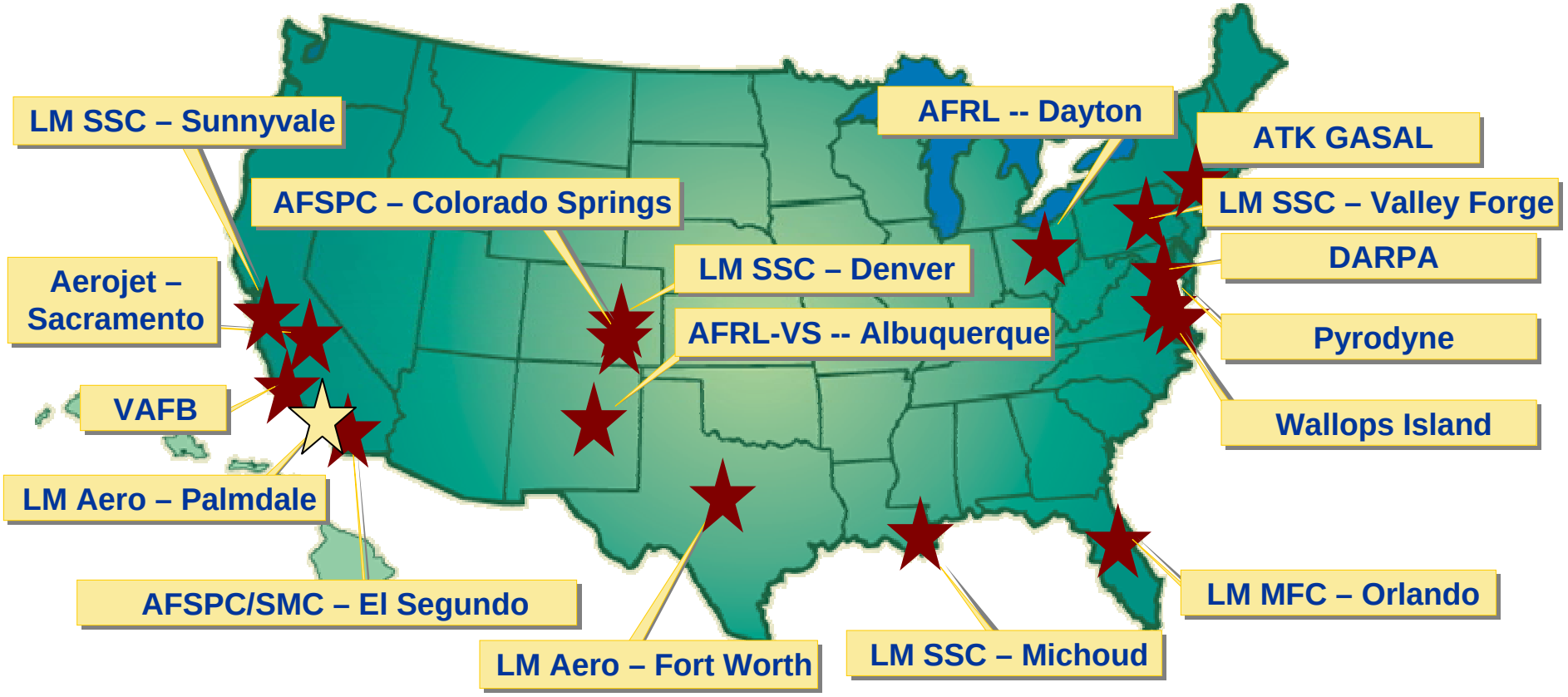
- *Allows for Early Flight Demonstrations*
- *Provides Multiple Opportunities for Acquisition Off-ramps*

PROGRAM SCHEDULE




LOCKHEED MARTIN
DARPA
Lockheed Martin selected for hypersonic technology development and flight demonstrations in phase II of the Falcon program.
FALCON
Distribution: Gov & Gov Contractors, ITAR Restricted
789-1000-9200

FALCON Program Team
Built on National Capability

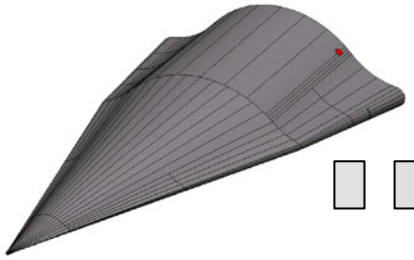


Phase 1 Output Summary

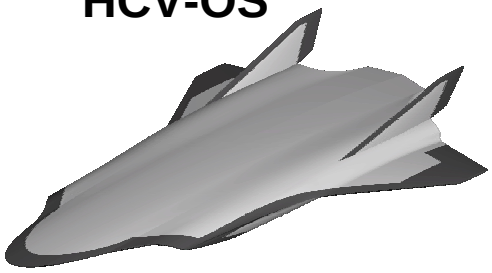
Phase I

Breakthrough HWS Operational System

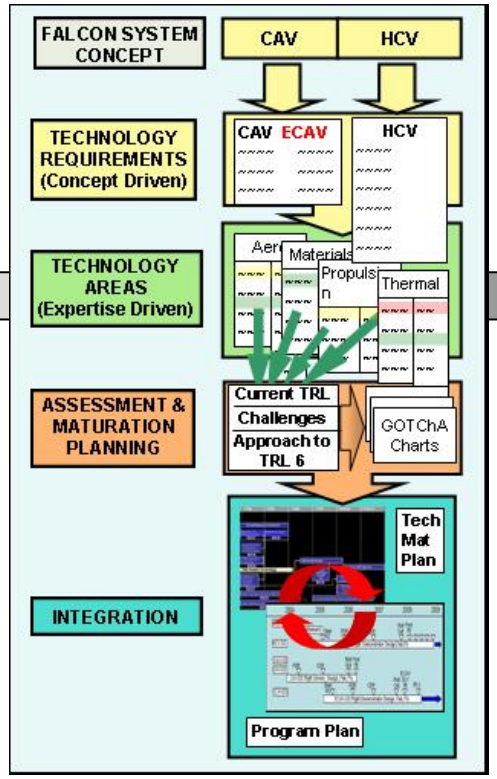
ECAV-OS



HCV-OS

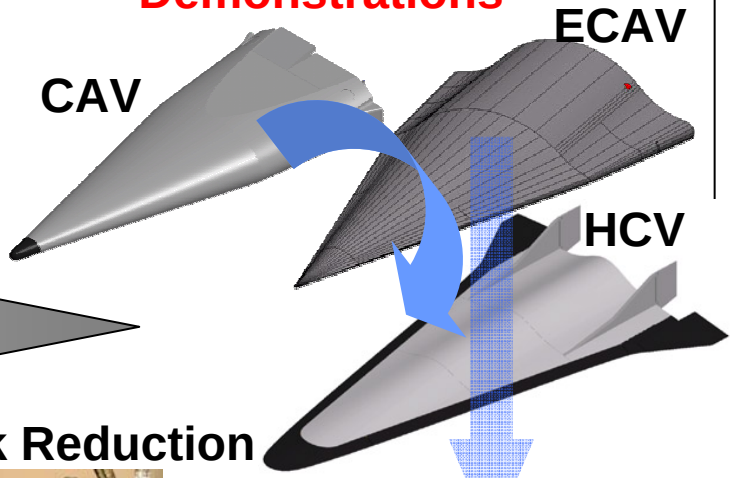


Integrated Technology Maturation Plan

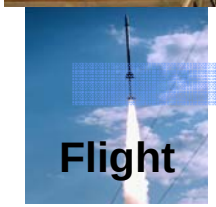


Phases II and III

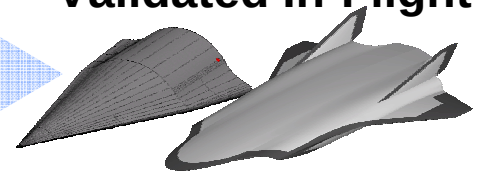
Linked Series of Flight Demonstrations



Risk Reduction



PGS Capabilities Validated In-Flight



Our in-flight demonstration program enables adoption of hypersonic prompt global strike solutions by the warfighter

FALCON CAV Operational System Meets Near Term Prompt Global Strike Objectives

Small Launch Vehicle System

+

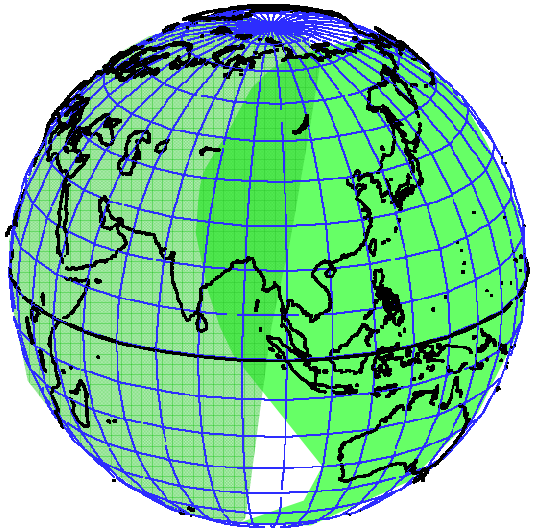
Advanced CAV Aero-shell and Insulation

+

Multiple Payload Carriage

High Lift/Drag Advanced GN&C and Communications

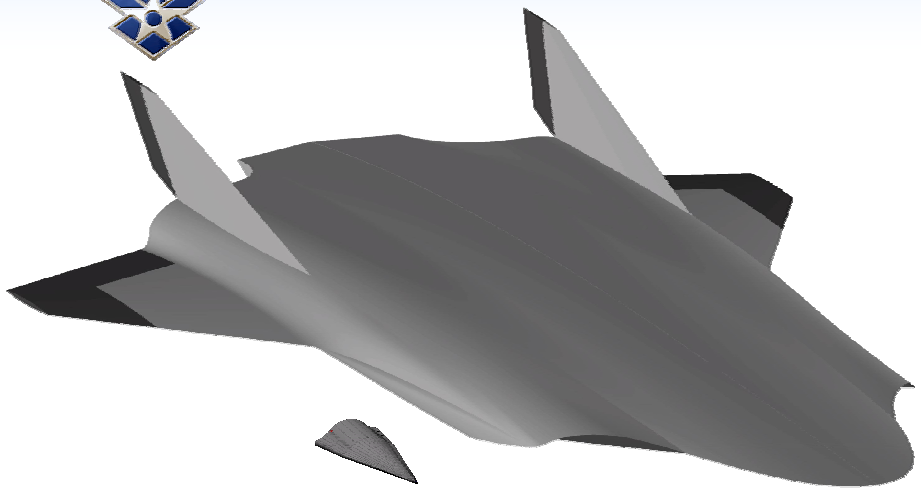
Enables CAV Global Reach from CONUS

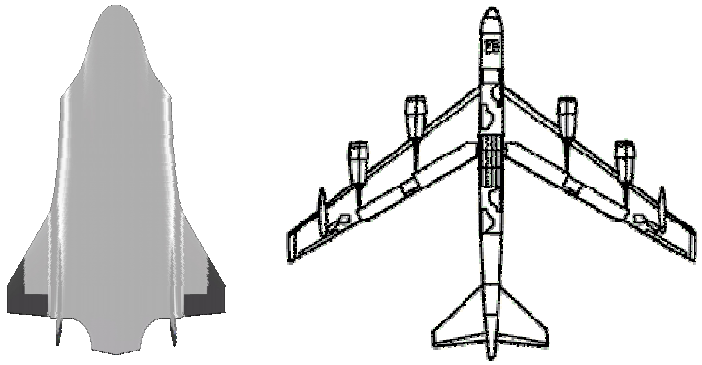


Terminate and Re-target Capability

Operation CAV/SLV System provides the warfighter with transformational prompt, precision worldwide strike capability from CONUS

FALCON HCV Operational System Meets Far Term Prompt Global Strike Objectives





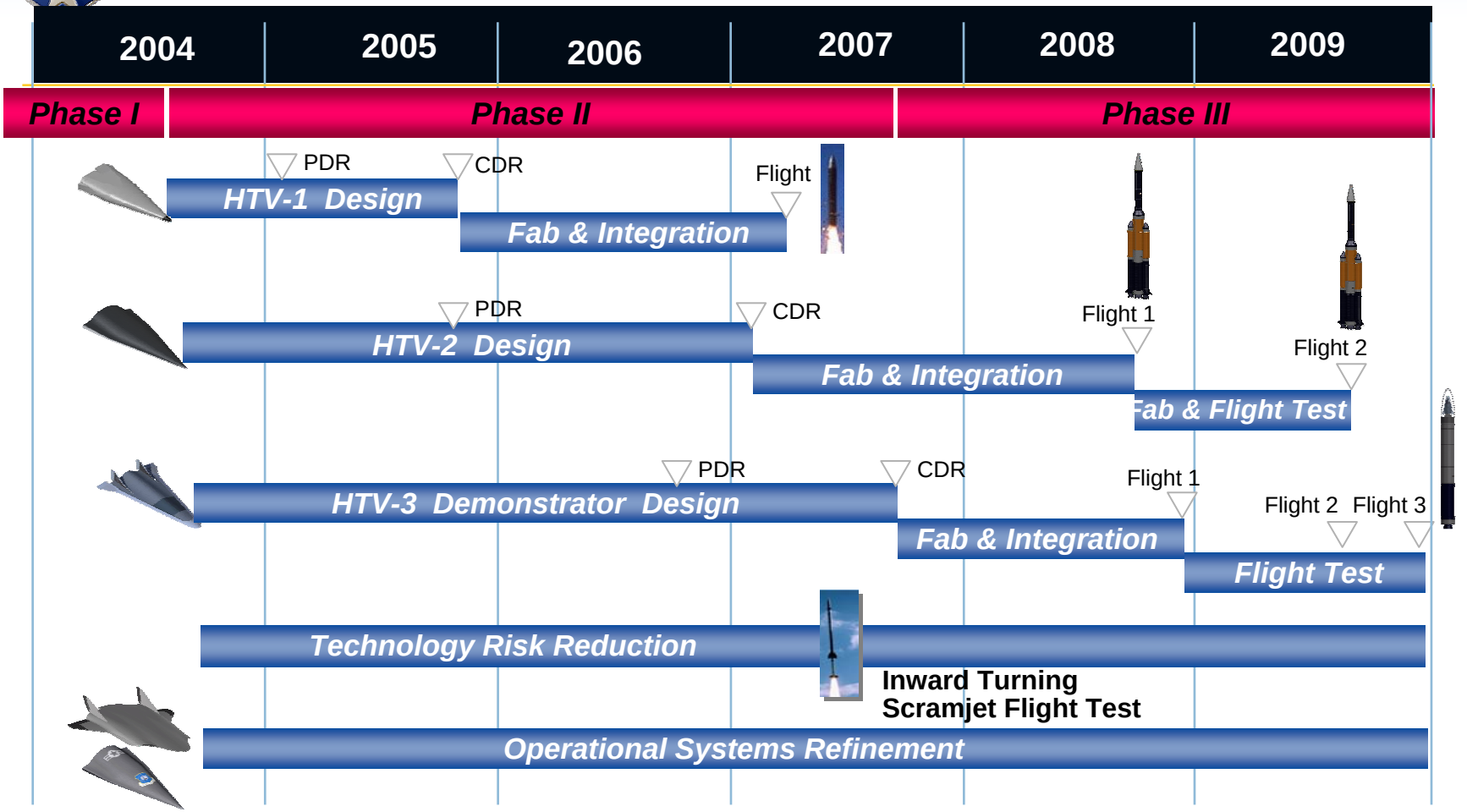
B-52 Size and Weight Class

Technology Advances Required for:

- **Aerodynamic Vehicle Design**
- **Inward Turning Propulsion System Integration**
- **Passive Small Radius Leading Edges**
- **Metallic Encapsulated Thermal Protection System**
- **Hot and Warm Structure Technologies**
- **Internal Cryogenic Insulation**
- **Conformal Tanks**
- **Mixed Phase Hydrogen Pumps**

FALCON HCV can strike the depth of any adversaries territory at a size and cost acceptable to the warfighter

FALCON Program Will Demonstrate Operational System Enabling Technologies



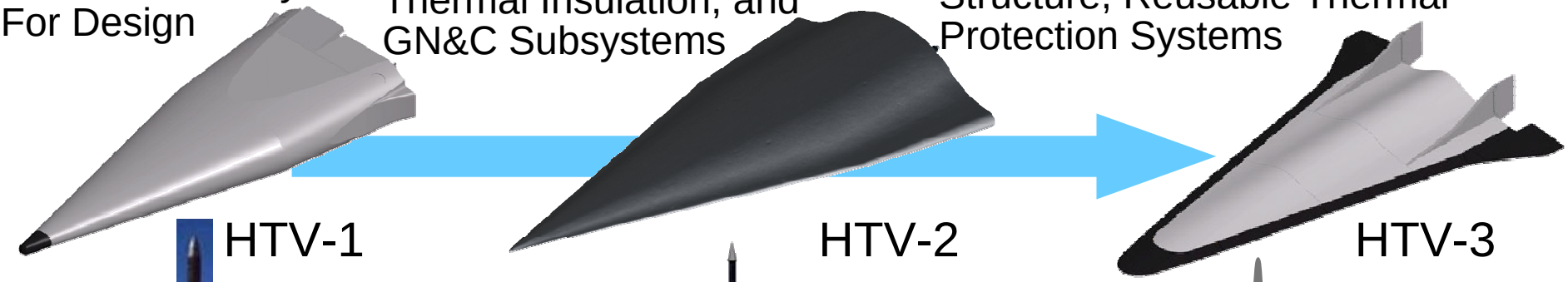
Three Distinct Hypersonic Technology Vehicles (HTV) Focus Technology Maturation in a Building Block Approach

FALCON Phase II & III Demonstrates PGS Technology in Building Block Flight Demo's

Low Risk, Ready For Design

Revise Aero Shell, Thermal Insulation, and GN&C Subsystems

Revise Aero Shell, Internal Structure, Reusable Thermal Protection Systems



HTV-1

GFE Booster Launched

Validates

CAV System and Subsystem Technologies In Flight

HTV-2

SLV Launched

Validates

All Enabling ECAV-OS Technologies In Flight

HTV-3

SLV Core Launched

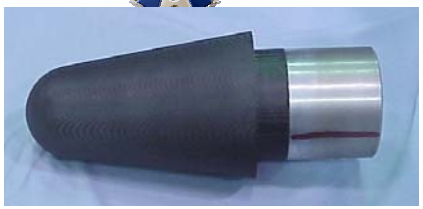
Validates

Enabling HCV-OS Aerodynamic & Structures Technologies In Flight

Inward Turning Engine Flight Demonstration Validates Enabling HCV-OS Propulsion Technologies in Flight

FALCON's evolutionary, spiral development flight demonstrator approach reduces technology validation cost and risk

HTV-1 Demonstration System Summary



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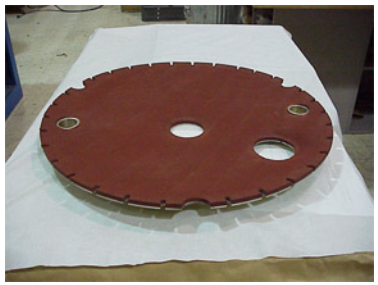
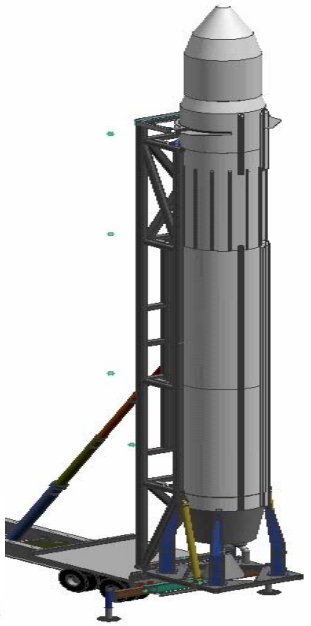


Aft Cover

HTV-1 uses state-of-the-art materials and components to reduce overall program risk and demonstrate today's Common Aero Vehicle hypersonic technology capability



Government Furnished Booster Launched

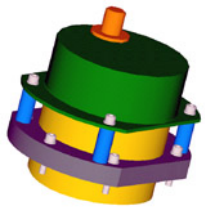
IR&D Aeroshell

Antenna Window

Carbon-carbon samples

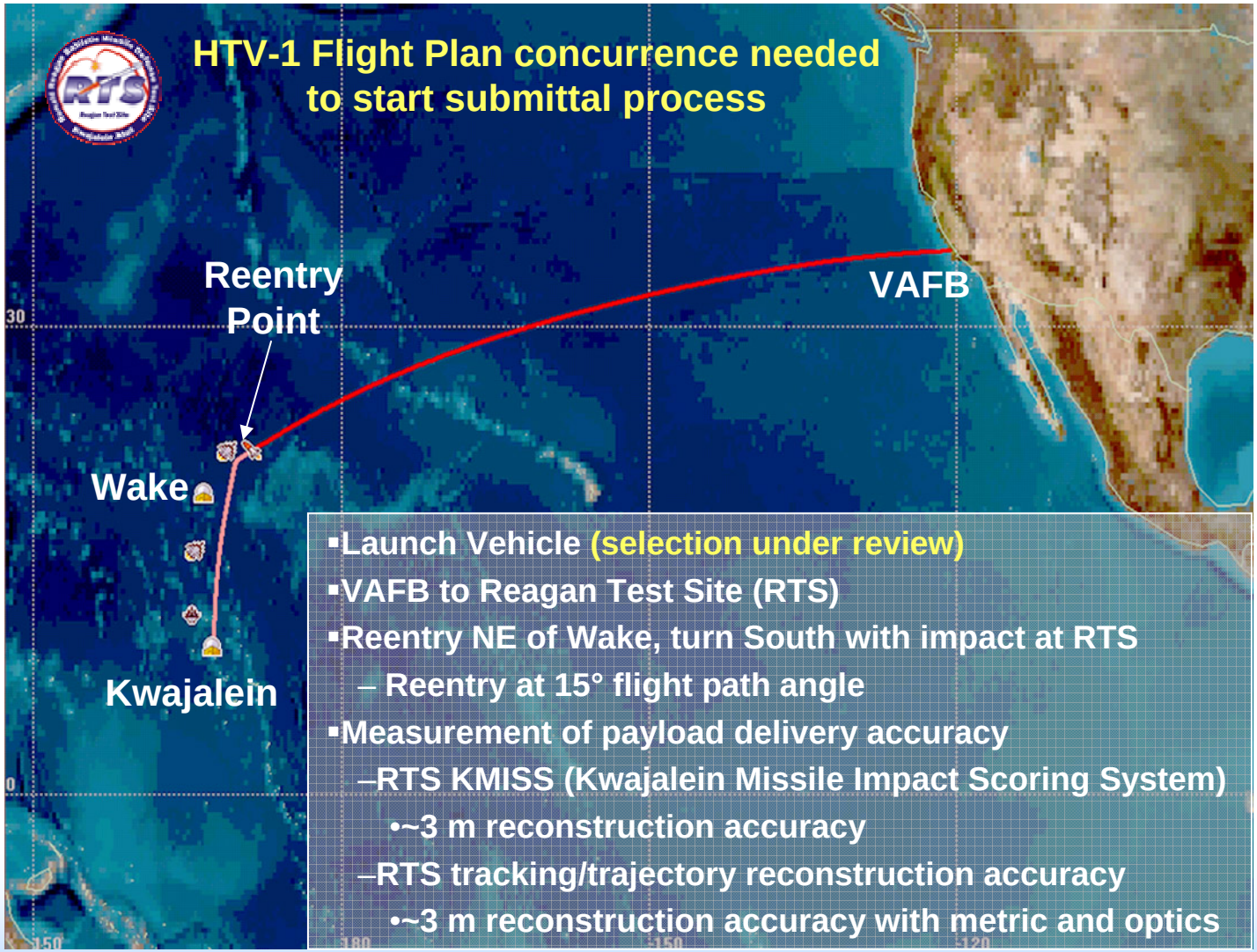
ESIGI

Encoder



Antenna

HTV-1 Flight Plan
Vandenberg AFB to Kwajalein via Wake Is.



- Launch Vehicle (selection under review)
- VAFB to Reagan Test Site (RTS)
- Reentry NE of Wake, turn South with impact at RTS
  - Reentry at 15° flight path angle
- Measurement of payload delivery accuracy
  - RTS KMISS (Kwajalein Missile Impact Scoring System)
    - ~3 m reconstruction accuracy
  - RTS tracking/trajectory reconstruction accuracy
    - ~3 m reconstruction accuracy with metric and optics

HTV-2 Objectives

Reference Trajectory

East launch, 28.5° latitude, VE = 23,500 ft/sec, hE = 350 kft

Key Objectives

- **Payload ~ 1000 lbs (TBD)**
- **Gross weight = 2000 lbs**
- **Downrange = 9000 nm**
- **Crossrange = 3000 nm**
- **Accuracy = 3 m CEP**
- **Global coverage**
- **Recallable and re-targeting capability**

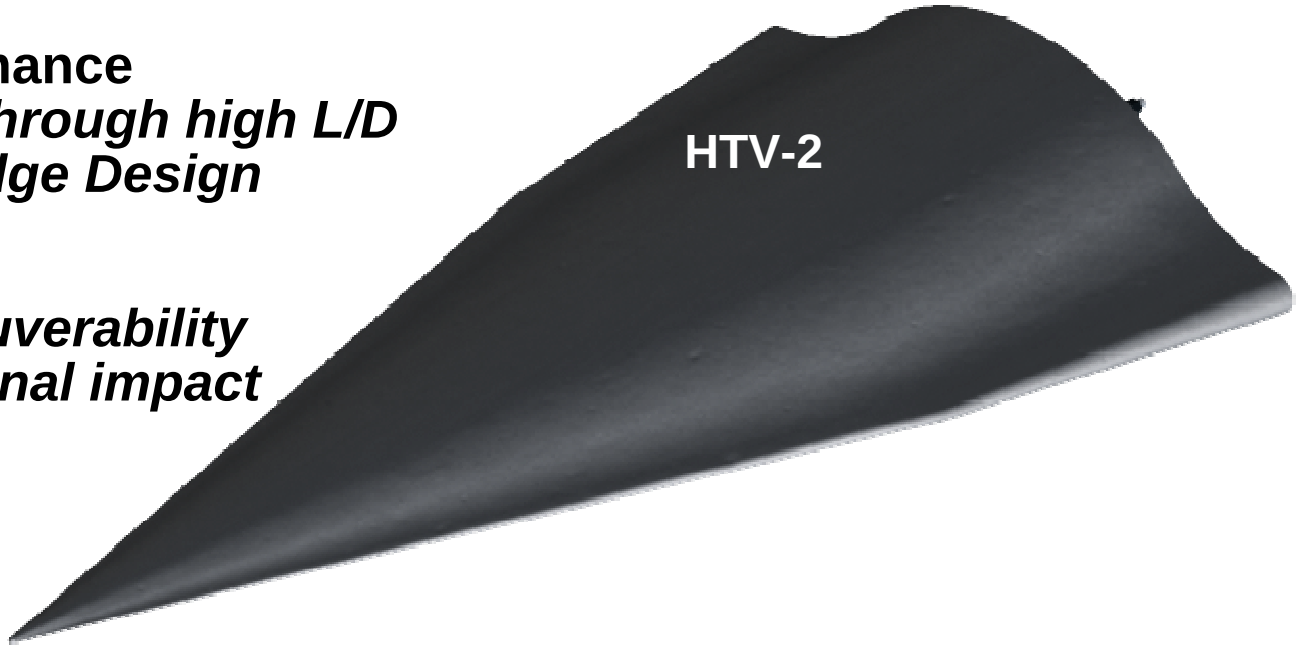
Additional Objectives

- **Impact velocity ~4 kfps (TBD)**
- **All-azimuth terminal maneuver capability**
- **Carriage & high-speed dispensing of payloads (TBD)**
- **Minimize collateral damage**

HTV-2 meets all objectives to provide flexible global capabilities

HTV-2 Demonstration System Summary

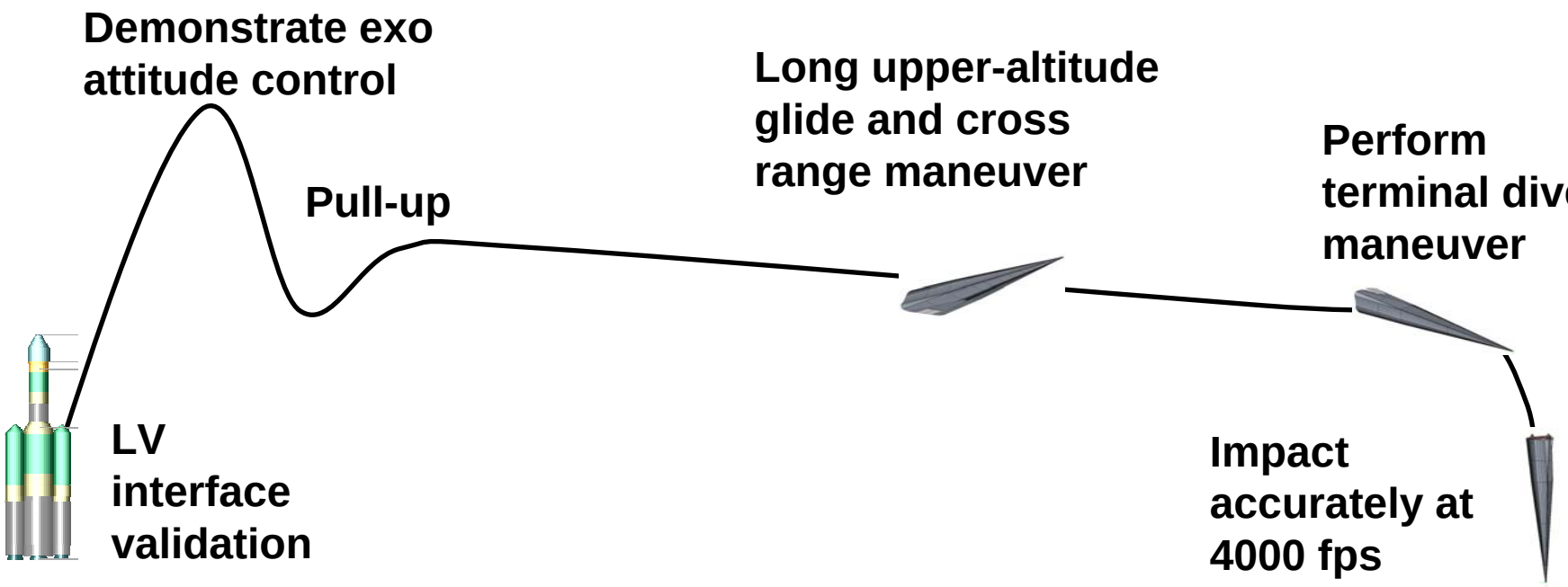
- **Thermal protection**
  - *Low recession carbon-carbon aeroshell*
  - *Advanced Multi-Layer Insulation for long duration reentry flight*
- **Aerodynamic performance**
  - *Extended range through high L/D*
  - *Sharp Leading Edge Design*
- **NG&C performance**
  - *Significant maneuverability required for terminal impact*



- **Communications**
  - *Maintain up/downlink throughout long-range flight*

HTV-2 Demonstrates Enabling Hypersonic Technologies for future Common Aero Vehicle Operational System

HTV-2 Flight-Test Profile



Other objectives

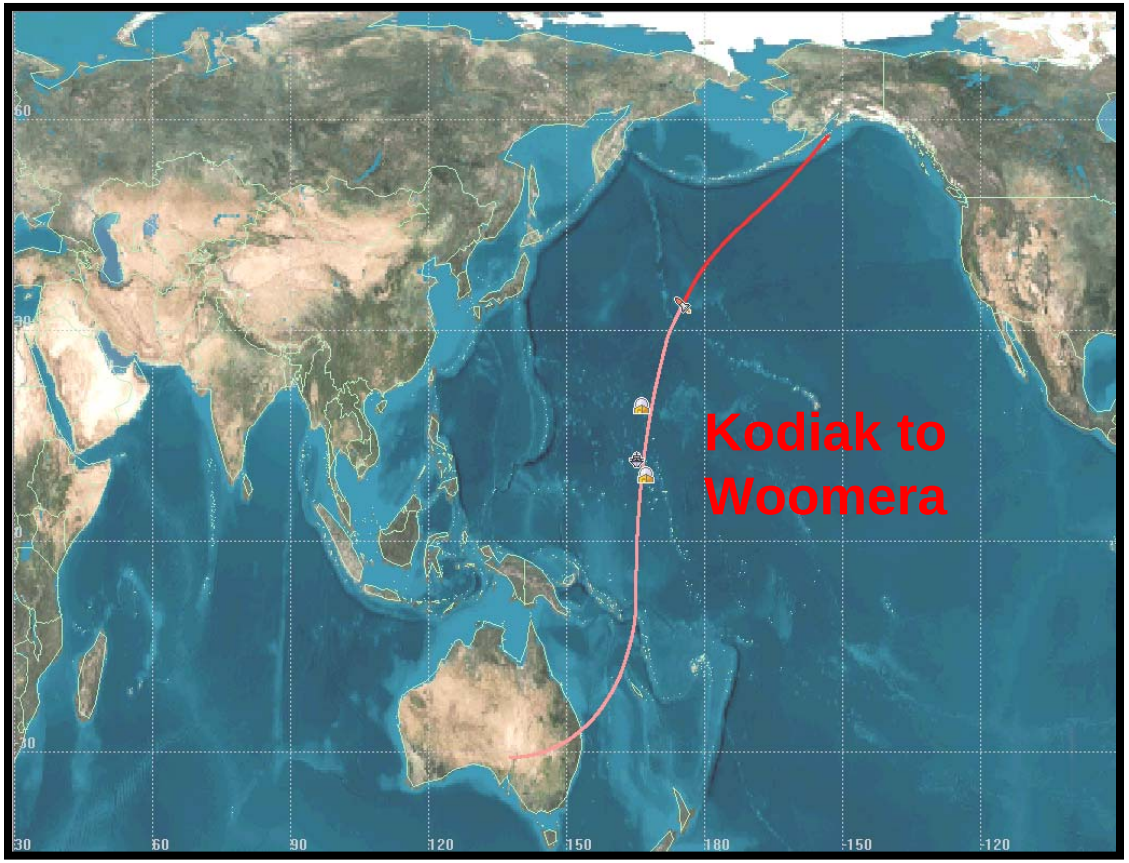
- Maintain flight safety throughout
- GPS acquisition during boost phase
- Command/telemetry link throughout mission

- Objectives for 1st flight shown
- 2nd flight options
  - repeat 1st with equipment updates
  - perform payload dispensing demonstration

Our flight profile demonstrates all important performance attributes

Proposed HTV-2 Flight Plan

- **SLV launch to reentry at 23,000 fps and 5° path angle**
- **Kodiak to Woomera (6200 nm) via Wake and Kwajalein**
- **Continuous tracking and telemetry use extended mobile range, AFSCN and MILSATCOM assets**
- **Overflight of populated Australian east coast**
  - Flight crosses coast >100 kft altitude
  - Controlled Flight Termination available
- **Terminal phase tracking available from Woomera**



HTV-2 flight plan provides long-duration test environments

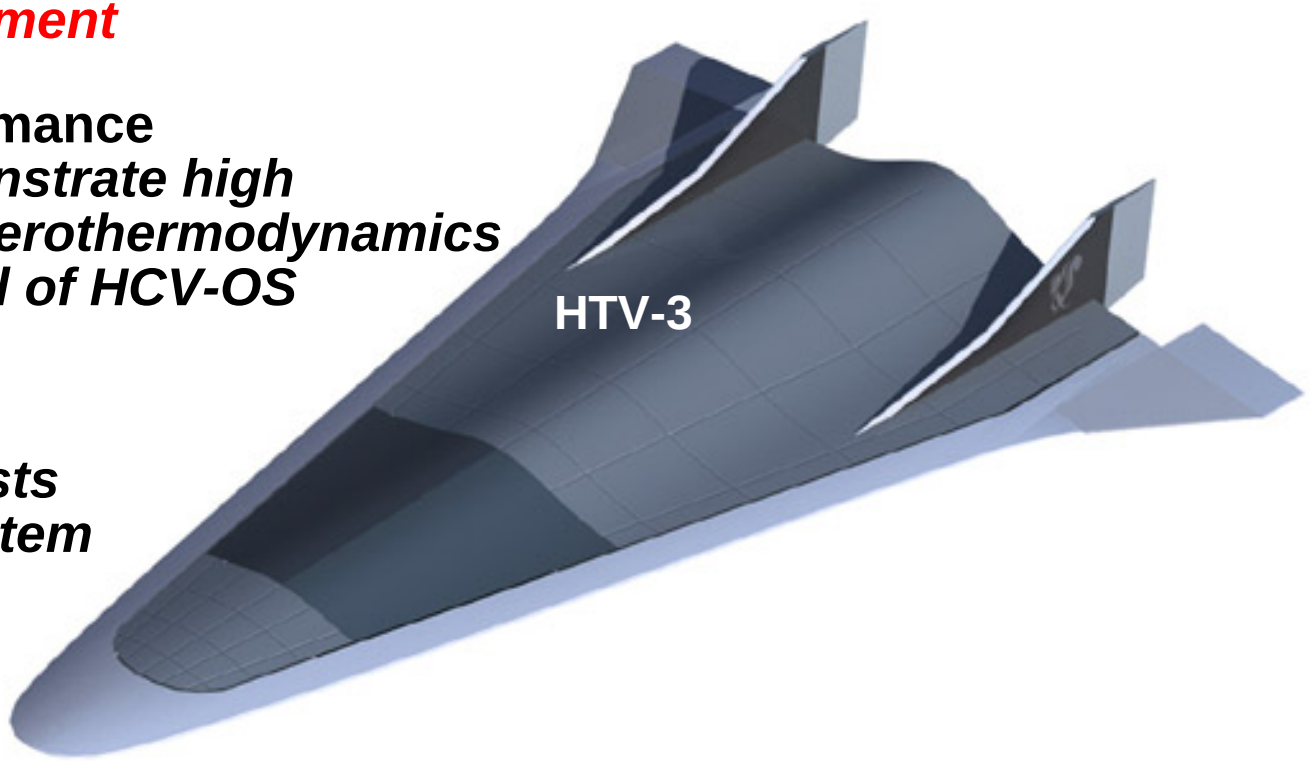
ECAV-OS Weight Traceability

	Weight (lbm)			Reduction Plan
			OS	
Payload			960	Customer Provided
Heatshield			400	Analysis refinement
Insulation			90	Analysis refinement
Structure			240	Analysis – g load reduction
Electronics			85	Actuator/battery refinement
Ballast			225	Structure/HS reduction, CG movement/aero refinement
Total			2000	

Roadmap defined to achieve 2000 lb ECAV-OS mass

HTV-3 Demonstration System Summary

- **Thermal Protection System (TPS)**
  - *TPS/Structure demonstrate capability for HCV-OS environment*
- **Aerodynamic performance**
  - *Shaped to demonstrate high aerodynamics, aerothermodynamics and flight control of HCV-OS*
- **Maximize Reuse**
  - *Multiple flight tests demonstrate system reusability/TPS refurbishment*



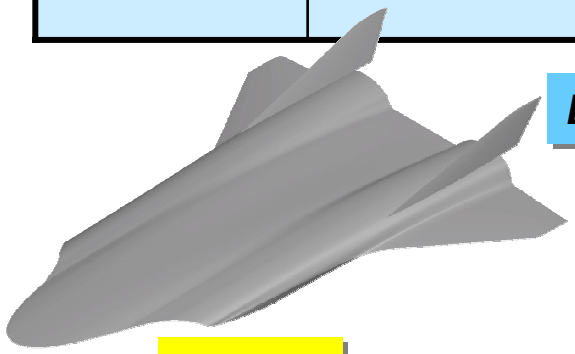
- **Builds upon HTV-1 and HTV-2 technologies**
  - *Technology risks minimized while payoff is maximized*

HTV-3 Demonstrates Enabling Hypersonic Technologies for future Hypersonic Cruise Vehicle Operational System

HTV-3 Design & Capabilities

HCV-OS primary objectives trace to HTV-DS design capabilities

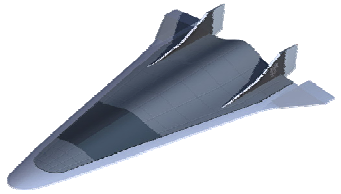
Mission Requirement	OS Design Objective	DS Verification Compliance
Global Reach 9000nm in 2 hours	➢ Mission performance via high L/D osculating flowfield waverider configuration	➢ Shaped to demonstrate high L/D wave-rider osculating flowfield aerodynamics, aerothermodynamics, flight control
	➢ High tolerance to thermal environment	➢ Demonstrate enabling TPS / structural technologies in OS flight environment
Aircraft-like operations	➢ Reusability with rapid 12 hr turnaround and minimum maintenance	➢ Perform multiple flight tests, demonstrating system reusability / TPS refurbishment



HCV-OS

Demonstrate Key Enabling Technologies

Osculating Flowfield Waverider shape
4000°F class passive TPS
3000°F class passive TPS
Lightweight acreage passive TPS
'Warm' structure-tankage-TPS integration



Low Risk Demo

HTV-3 is directly traceable to HCV-OS to mitigate risk of key enabling technologies

FALCON Materials IPT

- **Materials IPT (MIPT) focusing on materials issues (TPS and hot structures) for HTV-2 and HTV-3**
  - HTV-1 is assumed to utilize state-of-the-art materials
  - In the initial phases of the MIPT, only Airframe technology is considered. Propulsion hot structures will be considered at a later date as required/requested.

- **MIPT objectives**
  - Evaluate relevancy of ongoing government funded materials/design efforts to HTV-1, HTV-2, HTV-3, ECAV-OS, and HCV-OS needs.
  - Work with the FALCON prime to develop a materials plan that integrates MIPT efforts with contractor efforts
  - Recommend supplemental and new start efforts to fill technology gaps

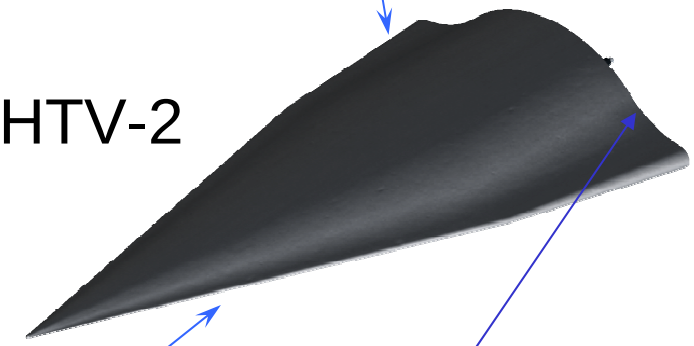
Critical Airframe Components

TPS/Hot Structures

Enhanced CAV (OS)

Leading edges
- Passive
- Ablatives

HTV-2



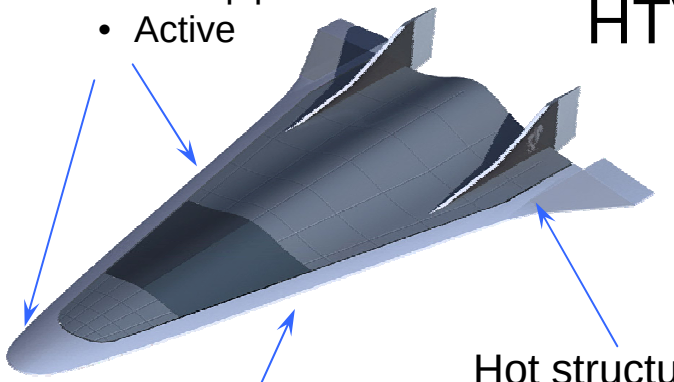
Acreage/aeroshell

Hot structures
Seals

Hypersonic Cruise Vehicle (OS)

Leading edges
- Passive
- Heat-pipe-cooled
- Active

HTV-3



Hot structures
Seals

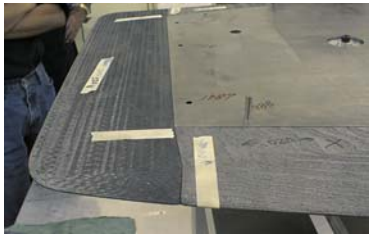
Acreage/aeroshell

MIPT FY04 Activities
Contracted Through UDRI

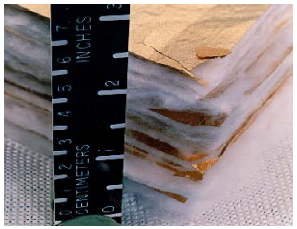
- **3000°F Carbon/Carbon Oxidation Protection**
  - C-CAT
  - Pratt & Whitney

X-37 C/C control surface

- **3600°F Refractory Composites**
  - Physical Sciences, Inc. (PSI)
  - Composite Innovations, Inc. (CIC)
  - ATK



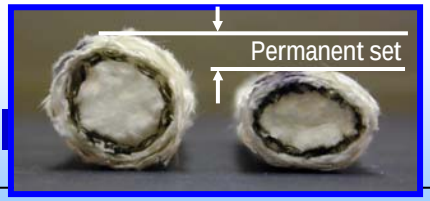
Sharp leading edge, T > 3600°F



German multi-layer insulation

FEA of TPS attachment

- **High Temperature Multi-Layer Insulation**
  - Refractory Composites, I (RCI)



Seals after use at 1900°F

FALCON…
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- **Unprecedented hypersonic technology validation in flight**
- **Building block approach maximizes payoff while minimizing technology risks**
- **TPS is the key technology**

Newly Established STRATCOM October, 2002
Unified Command - Given Global Strike Mission:
"Establish and provide full-spectrum global strike… to meet both deterrent and decisive national security objectives"
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